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Inverse estimation of the unsaturated soil hydraulic properties from tension disc infiltrometer data and electrical resistivity data

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An accurate and time-efficient estimation of unsaturated soil hydraulic properties in the field remains a challenge. Tension-infiltrometry is often used to determine unsaturated soil hydraulic conductivity and its spatial variability in the field. Due to capillary flow, a 3-D wetting bulb develops under the tension infiltrometer. The shape of the bulb depends mainly on the unsaturated soil hydraulic properties. In classical tension-infiltrometer experiments only the amount of infiltrated water is measured with time and used to infer soil hydraulic conductivity. Electrical resistivity tomography (ERT) offers the possibility to image the spatial distribution of bulk soil electrical conductivity from a set of apparent electrical resistivity (ER) measurements, which is related through a petrophysical model to the soil water content. Therefore, apparent ER data contain information about the 3-D structure of the wetting bulb, which may be exploited to infer soil hydraulic properties. Whether a combination of tension-infiltrometer and apparent ER data can be used to estimate soil hydraulic parameters was investigated in numerical experiments. Instead of using a tomographic inversion of the apparent ER data, i.e. ERTomography, to derive the spatial distribution of the wetting bulb from which subsequently hydraulic parameters are derived, we explore the potential of a joint inversion approach that derives hydraulic parameters directly from apparent ER data. The combined infiltration and apparent ER datasets showed that the soil hydraulic parameters could be inverted from a single infiltration experiment, which is not possible when only infiltration data are used for inversion. Application of the proposed method was performed on a silt clay loam. Results have shown accurate estimations on the saturated hydraulic conductivity and on the hydraulic parameters of the water retention curve.